Space Weather Technical Forecast

Issued on Saturday, 05 August 2023 at 01:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of further isolated M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout. Coronal Mass Ejection effects likely with a chance of G1/G2, Minor to Moderate Storm activity throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours is Moderate with an M-class flare observed at 04/0424 UTC from AR3386. Eight numbered sunspot regions feature on the visible disc and one un-numbered. The largest region AR3380 has rotated across the southwest limb leaving AR3386, in the northwest, as the current largest. Another couple of regions in the northwest AR3392 and southeast AR3394 are joint second largest regions and have not seen much change The remaining regions appear generally stable with little change. The aforementioned flare from the region in the northwest, AR3386 at 04/0424 UTC produced a CME (coronal mass ejection) which presents a risk of an impact early on Day 3 (7th Aug). No other significant CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind at L1, as measured by ACE/DSCOVR was slow-ambient to slightly elevated, generally between 330 and 350 km/s but increasing to 420-450km/s from around 04/0900 UTC, with a gradual decline back to slow-ambient levels thereafter. Density was near or below average, becoming slightly above from 04/1200UTC. The total interplanetary magnetic field strength (Bt) was Moderate before jumping to mainly strong levels from 04/0700UTC as an anticipated CME arrived, before easing back to moderate levels again by 04/2000 UTC. The north-south component, (Bz) was generally weakly positive but with occasional moderate southward directed orientations from 04/0700 UTC. Geomagnetic activity was Quiet to Unsettled with Active intervals to end the day.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at background levels throughout. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 1.39e6 integrated pfu noted at 05/0000UTC, with a slight upward trend observed.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low to Moderate, with the most likely M-class flare initially on Day 1 (5th Aug) from the recently departed region over the southwest limb AR3380, as well as the now largest region in the northwest AR3386 along with the two moderate sized regions in the northwest and southeast, AR3392 and AR3394.

Solar Wind / Geomagnetic Activity: The Geomagnetic forecast remains complex with several CME (coronal mass ejection) impacts probable through this coming period. A CME which left the Sun around 02/0900 UTC is considered to arrive Day 1 (5th Aug) or perhaps early into day 3 (6th Aug). A recent flare also produced a CME which presents a risk of an impact at Earth early

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on Day 3 (7th Aug). Solar winds have been generally slow, with some minor enhancement being felt from likely connection to a weak high speed stream (HSS). In the absence of any CME enhancement solar winds most likely remaining similar though the period. CME impacts however, most reliably from the 02/0900 UTC CME, could see solar winds reaching slightly elevated or perhaps elevated levels at times, 500-550km/s, particularly if they combine with HSS enhancement. Geomagnetic activity at Quiet to Unsettled levels (Kp2-3), becoming Active (Kp 4) at times with a chance (20-50%) of G1/G2, Minor to Moderate Storm intervals throughout.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is currently at background levels. There is a slight chance of enhancement from any notable flares that occur, most likely emanating from AR3380 in the near term. The high energy electron flux (greater than 10 MeV) is expected to remain at normal background to occasionally moderate levels through the period. The associated fluence therefore remaining below the Active threshold (1e8 total pfu).

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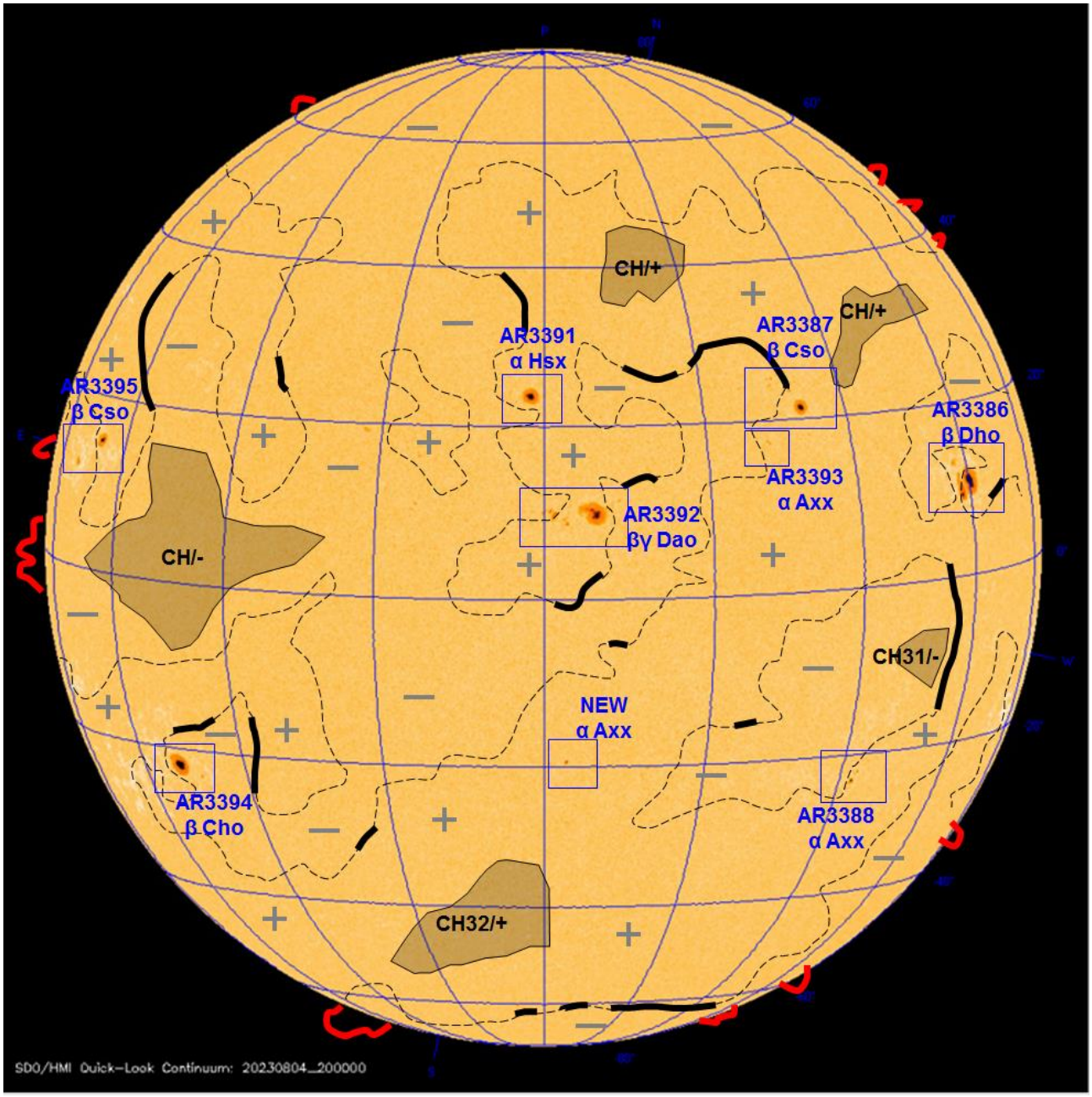
Figure 1. Solar Analysis Valid 2000 UTC, 4 August 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The Geomagnetic forecast remains complex with multiple CME impacts possible. A solar filament lifting off the sun's surface was observed centre disc around 31/1800 UTC, alongside a C5 flare from AR3380 with a likely associated CME appearing towards the southwest. In addition, two filament lift offs from the northeast disc produced a CME towards the northeast. Both of these are considered to have an Earth directed component, with influence continuing into Day 1 (5th Aug). In addition to these two CMEs, a full-halo CME left the Sun around 02/0900 UTC. This is considered to arrive Day q (5th Aug) or perhaps early into day 2 (6th Aug). A long period M1.9 flare from the northwest disk around 04/0424 UTC and likely associated filament lift off produced a CME which has been modelled as presenting a risk of an impact early on Day 3 (7th Aug), and ensemble products indicate a later arrival is possible into the start of Day 4 (8th Aug). Solar winds have been generally slow-ambient, with some enhancement being felt from likely connection to a weak high speed stream (HSS) from either CH31/- or perhaps an unnumbered CH/+ in the northwest disc. Both these features are low confidence however they are coincident with more well defined and likely stronger coronal holes on the previous rotation. In the absence of any further CME enhancement solar winds are likely to change little however CME impacts, most reliably from the 02/0900 UTC CME, could see solar winds reaching slightly elevated or perhaps elevated levels at times, 500-550km/s, particularly if they combine with HSS enhancement. Geomagnetic activity at Quiet to Unsettled levels (Kp 2-3) becoming occasionally Active (Kp 4) intervals with a chance (20-50%) of G1//G2, Minor to Moderate Storm intervals throughout this guidance period. In the table above there is a slight (5%) chance for an isolated G3/Strong geomagnetic storm interval.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	30	50	20
Strong	G3	No	5	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
02/1600	Partial	Filament eruption	Centre disc	520 km/s	05/1700 UTC	Direct hit possible
04/1034	Partial	Flare / Filament eruption	NW	605 km/s	07/0700 UTC	Direct hit possible

Figure 2: Latest MOSWOC ENLIL model ensemble output, showing a spread of arrival times for the two CMEs.

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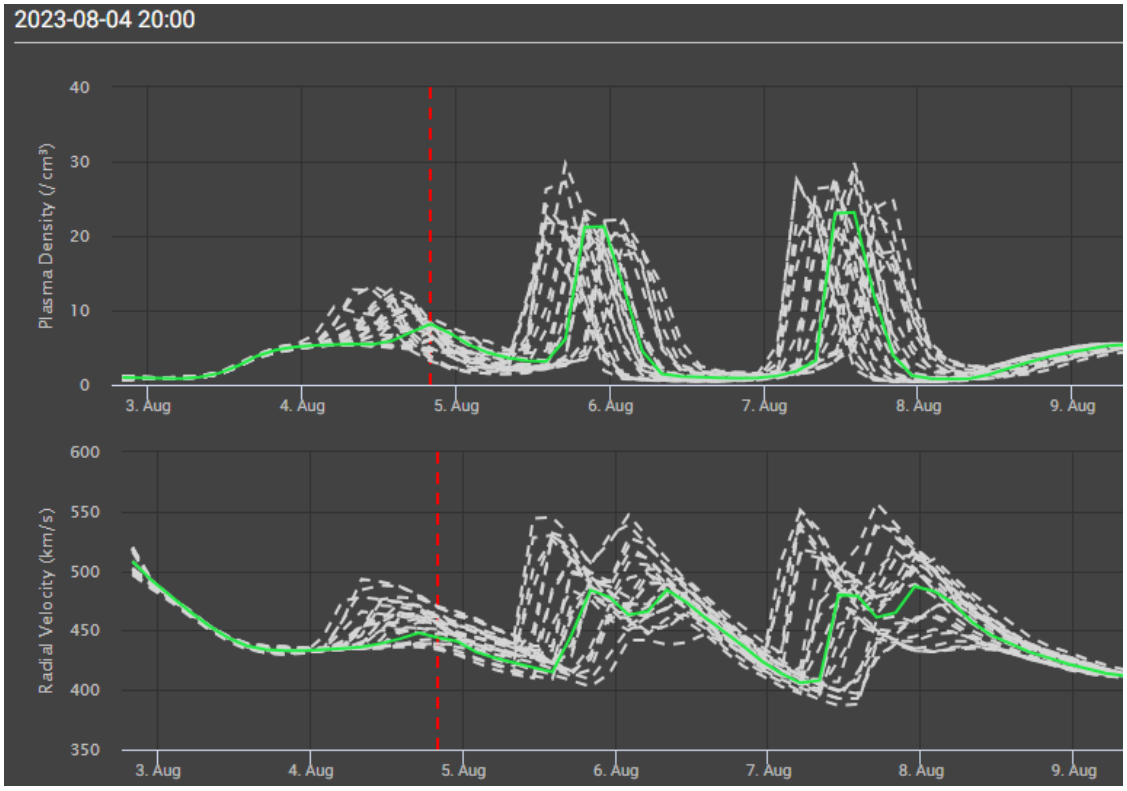

Radio Blackouts - X-Ray Flares:

Nine active regions feature on the visible disc, and one un-numbered region. The largest region over the past few days has been AR3380 (Dac/Beta-Gamma-Delta) which has now disappeared over southwest limb to the far side of the sun's disc. AR3386 in the northwest is now the largest region, located in the northwest, (Dho/Beta) and has seen some areal growth and flare activity. Remaining regions, including those that have recently rotated on from the eastern limb, appear generally stable or are in slow and erratic decay.. Solar activity is most likely to be Low with the most likely source of M-class flare activity in the immediate term still AR3380. AR3386 (Dho/Beta) in the northwest is also a contender as are the two other moderately large regions AR3392 (Dao/Beta-Gamma) and AR3394 (Cho/Beta) in the northwest and southeast respectively, and contribute much of the risk of any further M-class flares. The arrival of further active regions across the eastern limb is anticipated to be most probable later in the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	30	20	30
Very Active	R3 to R5 X Class	No	5	5	1	5

Figure 3: : Latest 24hr X-ray flux at GEO from GOES with one M-class flare at 04/0424 UTC.

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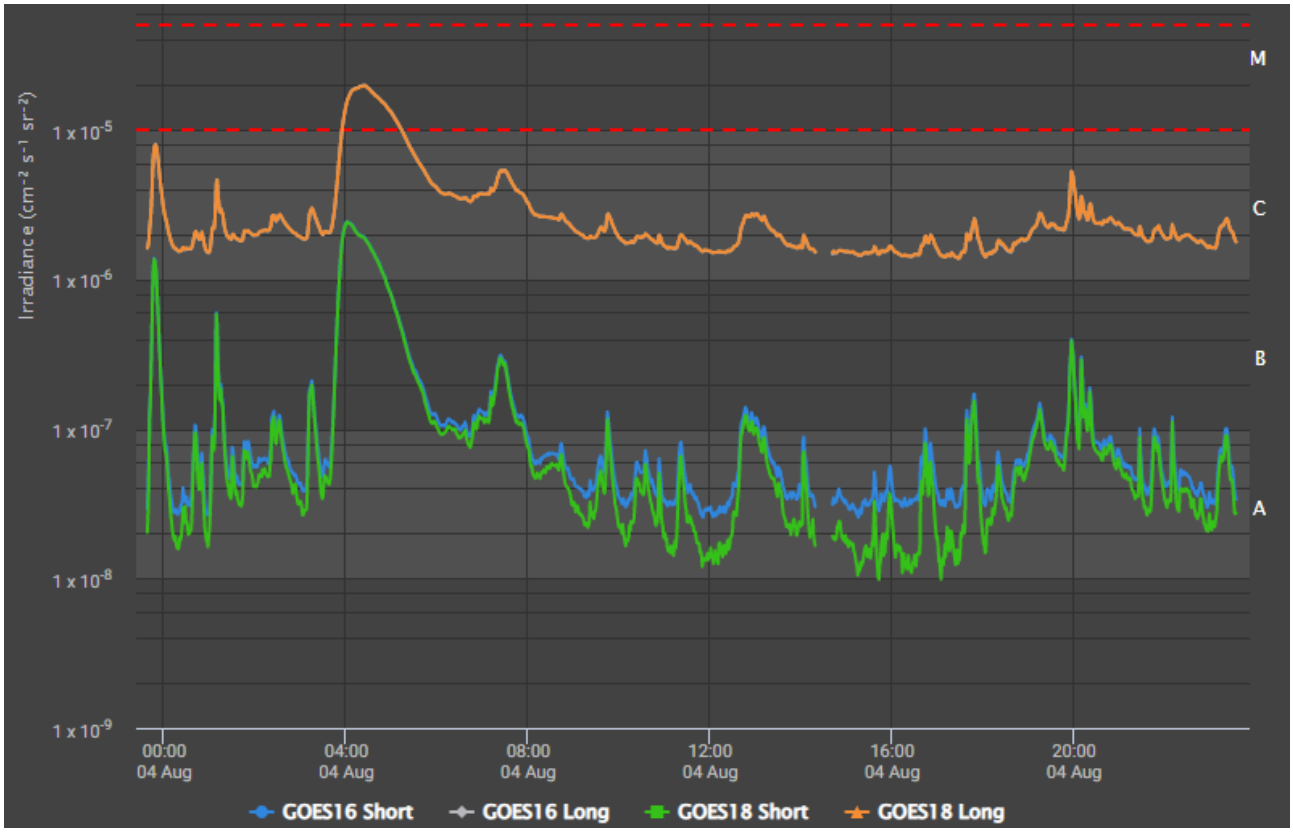

Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is at background levels. The main risk of enhancement and exceedance of the S1/Minor Storm threshold, comes mostly from the complex region AR3380 departing the limb of the southeastern edge of the visible disc. This risk reducing into Day 2 onwards.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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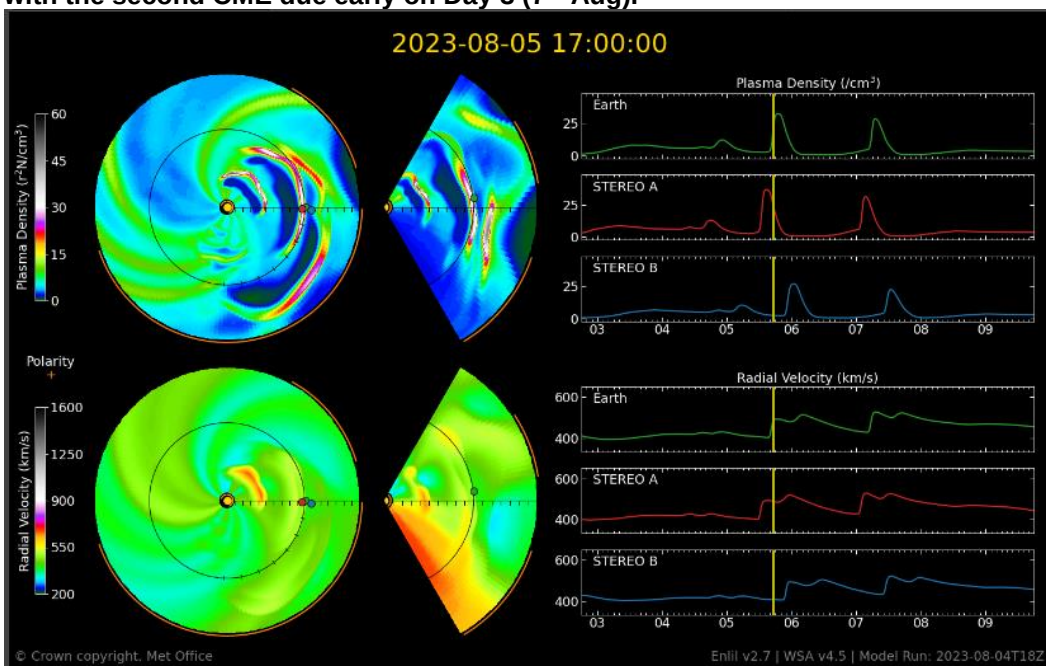
Figure 4: Met Office ENLIL guidance showing arrival at Earth of first CME later on Day 1 (5th Aug), with the second CME due early on Day 3 (7th Aug).

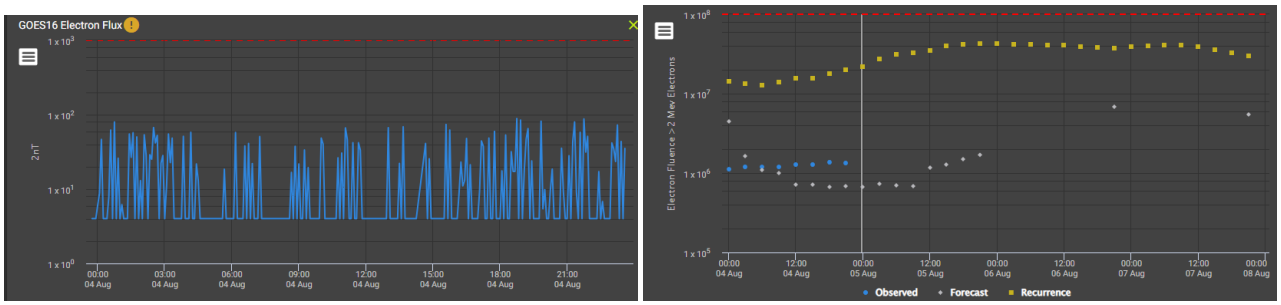


High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 10 MeV) is currently expected to remain at normal background to moderate levels through the period, as CME potential and the lack of significant high speed streams lead to likely suppressed flux values. The associated 24 hour fluence is forecast to remain below Active (1e8 total pfu). The Met Office REFM output is currently giving good guidance with a mostly flat trend continuing.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	5	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: Met Office high energy electron flux at GEO and Met Office REFM guidance.



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